Journal of Air Law and Commerce

Volume 25 | Issue 4 Article 2

1958

A Map Analysis of United States Airline Competition

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A MAP ANALYSIS OF UNITED STATES AIRLINE COMPETITION[1]

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Part II — Competition and Growth

In the first part of this study[2] the development of airline competition among the 99 leading city pairs[3] was portrayed in a series of maps. In part the purpose of the first article was to provide a clear picture of individual route competition in the broader competitive setting of the leading city pairs; in part, it was to determine meaningful competitive categories for the evaluation of the relation between competition and growth. From the map examination it was evident that a consideration of prewar to postwar growth involved such sweeping competitive change as to render it of questionable significance as a study period. Of the other two periods represented on the competitive maps, 1949-1954 was a period of competitive stability, 1954-1956 was a period of competitive change associated with the initial impact of the recent round of CAB decisions. If one considered 10 per cent competition as effective competition, the 100 city pairs could be divided into one-, two- and three-carrier pairs.[4] Those pairs which had no single-carrier service were grouped with the one-carrier pairs; those which had more than three effective competitors were grouped with the three-carrier pairs.

In this second part of the study, the growth pattern of the 99 city pairs is mapped both for the period of competitive stability and the

[1] Both Part I and Part II of this study represent some preliminary findings of an empirical investigation of the traffic characteristics of the leading city pairs. The investigation is being carried on in connection with a Transportation Center study of CAB regulatory policy. Any conclusions are, of course, quite tentative in nature. It is hoped, however, that this cartographic and tabular presentation will act as a stimulus to communication from airline research and traffic personnel regarding more detailed and realistic interpretation of the growth and competitive characteristics of individual routes.

[2] Edward J. Taaffe, "A Map Analysis of United States Airline Competition—Part I: The Development of Competition," Journal of Air Law and Commerce, XXV, (Spring, 1958) pp. 121-147.

[3] As is discussed in Taaffe, *op. cit.*, p. 122, only 99 of the 100 leading city pairs are mapped. Tampa-Chicago and St. Petersburg-Chicago, both of which were included among the 100 leading pairs in March, 1956, are considered as a single pair.

[4] Although the ten per cent definition has been used by Gill and Bates and others, its arbitrary nature should be noted at the outset. As a partial compensation for this, some of the findings in this study are also checked against a five per cent definition. Even this has serious weaknesses, however. A carrier may be quite inactive over a route and still, by its very existence, constitute a potential threat which may have an effect on the other carriers which is indistinguishable from the effects of an active competitor. The definition of competition for purposes of evaluating its growth effects becomes even more difficult when one considers that the anticipation of possible competition may also cause a carrier with a monopoly route to behave like a competitor. This is particularly true of a period of route awards such as 1955-1956.

period of competitive change. Each of these patterns will be examined, first, to determine principal growth factors, then for evidences of significant differences in growth between one-, two-, and three-carrier pairs after adjustments have been made to modify these growth factors. Differences in percentages of coach travel will also be examined for evidences of relation to number of competitors. Finally, the city pairs which experienced an increase in the number of effective competitors will be mapped separately and their growth rates compared with those of the city pairs which did not experience an increase in effective competition.

In some respects, therefore, this study is similar to the previous studies cited.[5] The findings in these were essentially negative in regard to any relationship between growth and competition. An important difference in this study, however, is the fact that it covers the period after 1949 when the initiation of coach services added a new dimension to airline competition. In addition, explicit attempts will be made to eliminate Florida traffic, to modify the length-of-haul factor, and to note other possible complicating factors by observing pertinent growth rates in the map context of the 99 city pairs.

Traffic Growth from 1949 to 1954

Figure 1 presents the growth in air traffic over each of the 99 city pairs from 1949 to 1954. The base map is the same as that used in the article dealing with the development of competition.[6] Each circle on the New York inset, for instance, represents the 1956 passenger-miles between New York and that city graded into three magnitude categories. Of the 99 leading city pairs in March, 1956, all but 12 are represented by the circles on the New York, Chicago, Los Angeles and Miami maps. These twelve are represented by squares. On the Chicago inset, the squares represent Washington traffic, on the Los Angeles inset they represent San Francisco traffic and on the Miami inset they represent Tampa traffic.

The red and the black-and-white patterns in the circles represent percentage rates of growth. The histogram-legend in the lower left hand corner presents a frequency distribution of the 99 growth rates. The

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[5] Frederick W. Gill and Gilbert L. Bates, *Airline Competition*, (Cambridge: Harvard University Press, 1949); Herbert H. Whitehead, "Effects of Competition and Changes in Route Structure on Growth of Domestic Air Travel," JOURNAL OF AIR LAW AND COMMERCE, XVIII (Winter, 1951), pp. 78-90; Harold D. Koontz, "Domestic Airline Self-Sufficiency: A Problem of Route Structure," *American Economic Review*, XLII (March, 1952), pp. 103-125; Gilbert L. Bates, "Current Changes in Trunkline Competition," JOURNAL OF AIR LAW AND COMMERCE, XXII, (Autumn, 1955) pp. 379-405.

[6] For a thorough discussion of this base map, see Taaffe, *op. cit.*, pages 123-125. All data represent two-way traffic and were again drawn from Civil Aeronautics Board, *Airline Traffic Survey*, Washington, D. C.: U. S. Government Printing Office, and Air Transport Association, *Origination-Destination Airline Revenue Passenger Survey*, Airline Finance and Accounting Conference, Washington, D. C. March and September totals were used in all cases. In the case of 1949 to 1954 growth rates, the 1954 figures were corrected by a factor of 2.21 to allow for differences in survey periods. The author wishes to express his thanks to John T. Hoare, graduate student in geography, for cartographic assistance.

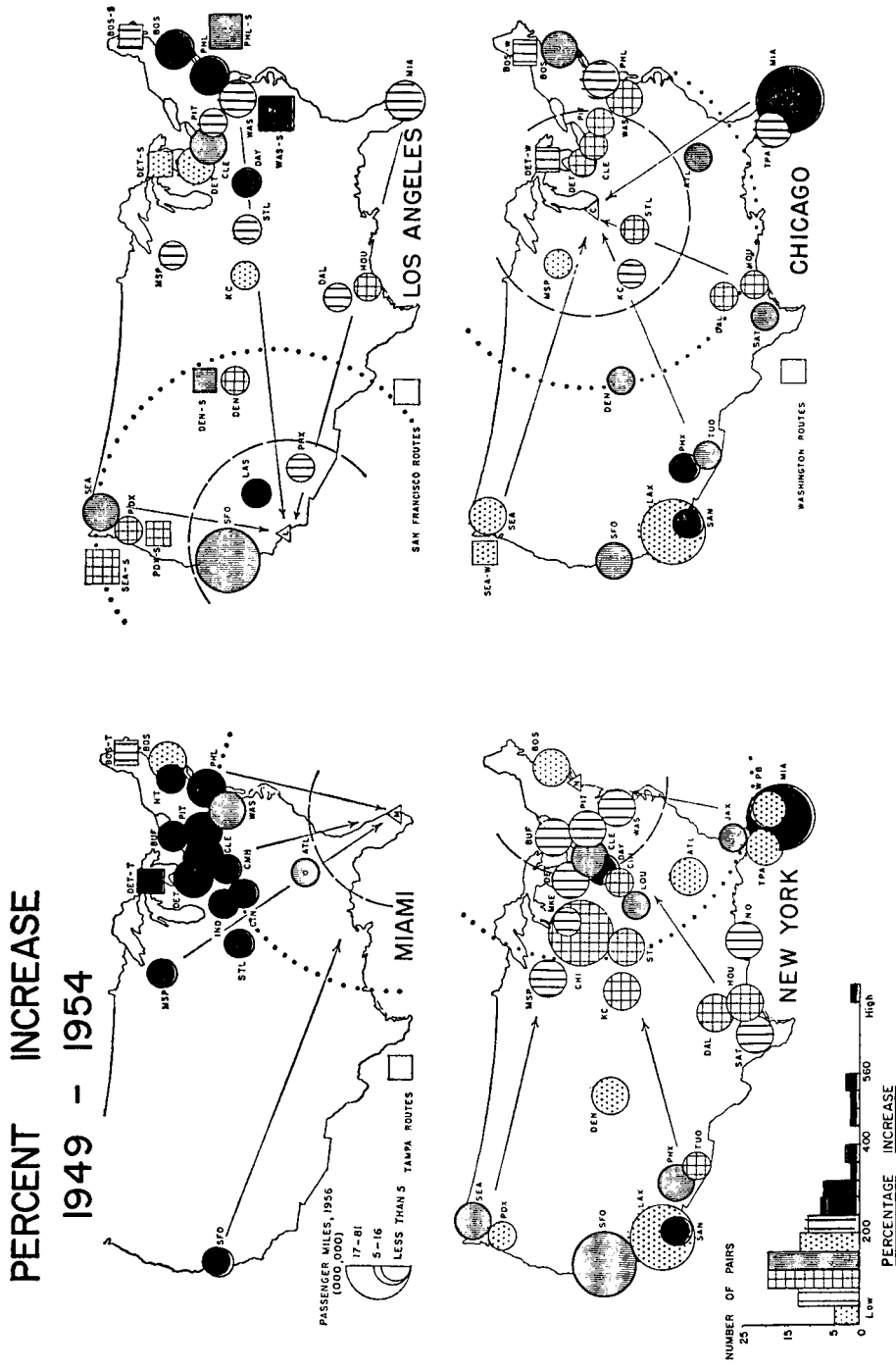

Figure 1 — Percentage Increase in Air Traffic from March and September, 1949 to March and September, 1954

shaded category is approximately centered on the mean;[7] the red categories represent growth rates greater than average; the black-and-white categories represent below-average growth rates. Each bar in the legend represents roughly one-half a standard deviation. Note that there are a number of high-increase bars on the red open-end category, which represents growth rates above 241 per cent. As growth rates increase from the average, the red pattern becomes more intense, from dots, to lines, to solid color; as growth rates decrease, the black-and-white patterns become less intense, from cross-hatches, to line, to dots. Thus, on the Chicago inset, the shading in the Boston circle indicates that the Boston-Chicago growth rate fell in the average category from 121 to 160.5 per cent; the line pattern in the Boston square indicated that Boston-Washington traffic fell in the first category below that of the average (roughly between 1/4 and 3/4 of standard deviation below the mean).

The most conspicuous features of Figure 1 are the high rates of increase noted at the Florida resorts and at the long-haul cities. Air passenger traffic to the Florida resorts increased at a phenomenal rate from 1949 to 1954. Miami, Tampa, and other Florida city pairs had an average rate of increase of 288 per cent, more than twice the 136 per cent increase for all domestic traffic. There were eight growth rates greater than 325 per cent among the 99 city pairs. One of these was the Los Angeles-Las Vegas route; all of the rest were on the Miami-Tampa map. Growth in Florida traffic seemed to be distributed among northern cities with little concern for the presence of single-carrier services or the effectiveness of coach services offered.[8] High rates of increase will be noted at cities with no coach service (Indianapolis, Columbus, and Hartford), with no single-carrier service (Minneapolis), and with neither single-carrier nor effective coach service (Buffalo). It is also interesting to note that the very highest growth rates (those above 300 per cent) in Florida traffic were not recorded at the high density, relatively long-established New York and Chicago routes (see New York and Chicago insets) but at such other American Manufacturing Belt cities as Detroit, Cleveland, Pittsburgh, and Philadelphia. At some of these cities markedly better services had been initiated during the period.[9] The higher and more consistent Florida increases sets them clearly apart from the Arizona and California increases, which may also be associated with resort travel. For most purposes of this study, there-

[7] More accurately, the shaded pattern is centered on the mean for the 75 non-Florida pairs. The red-dotted category is centered on the mean for the entire 99 city pairs. Table 1 in the appendix lists the values for each of these categories as well as growth rates, coach percentages and number of ten per cent competitors for each of the 99 pairs.

[8] Coach percentages for each city pair are included in Table 1 in the appendix. These figures were added to work maps to facilitate analysis, but, as will be noted from the tables, their relation to growth was too weak to justify inclusion on final maps.

[9] It should also be noted, however, that this is, in part, related to the problem of comparing percentage changes of quantities which have a fairly wide range of magnitude.

fore, the 24 pairs involving Florida traffic will be excluded from consideration. In many instances, the Los Angeles-Las Vegas traffic will also be excluded.

The relatively greater growth of long-haul than of short-haul cities is evident in the general tendency for the shaded (average) and red (above-average) patterns to predominate on each inset map as distance increases from the city concerned. This tendency is emphasized by the curved lines on the map which represent the 500 and the 1,000-mile distance zones. The dotted lines, representing the 1,000-mile zone, serve as a rough boundary between the high and the low growth rates (see the Miami and Los Angeles maps). Long-haul California traffic experienced particular growth. The 33 city pairs which include California traffic had an average rate of growth of 189 per cent, compared to the total growth of 136 per cent. The over-all correlation between length of haul and rate of growth was measured by simple linear regression. The result was a correlation coefficient of .40 (excluding the Florida resort routes) which tested as significant but only accounted statistically for 16 per cent of the variation.[10]

Table 1 presents another view of this relationship.

Length of Haul	*Average Rate of Increase*
0-500	104
500-1000	124
1000-1500	171
1500-2000	201
Over 2000	191

It will be noted that there is a fairly regular progression of average rates of increase with broad distance zones. The slight drop-off from the 1500-2000 mile zone to the over-2000 mile zone is probably associated with slight differentials in growth between some of the long-haul, high-increase California routes. Many routes departed markedly from this progression as is clear from the map. New York routes to Cleveland and Dayton, as well as Chicago routes to Boston and Philadelphia are examples of average or high-increase, short-haul routes. New York routes to New Orleans, the Texas cities and Tucson are low increase, long-haul examples, as are Los Angeles routes to Kansas City and Texas.

A third possible growth factor is represented by the percentage of coach passengers on each route, as listed in Table 1 in the appendix. The percentage of coach passengers on a given route should be related to both the amount and the effectiveness of coach services offered. Routes which have a large number of coach flights scheduled at convenient hours would presumably have a considerably higher proportion of coach passengers than comparable routes with coach flights scheduled

[10] In the absence of precedents it is difficult to say whether such a coefficient is really relatively low as it would appear. Cross-section analyses of growth rates on individual routes might be expected to be quite erratic and such a coefficient might actually be high. Such haphazard factors as bad weather, conventions, etc. probably have considerable impact on the two-week survey period. The use of correlation measures in this instance is less as an index of closeness of relationship than as an expedient to facilitate comparison.

at inconvenient hours. Thus, we might expect a positive relationship between growth rates and percentage of coach passengers. Inspection of Table 1 in the appendix indicates that this relationship is quite weak. Regression analysis gives a correlation coefficient of .23 which is significant at the five per cent level but not at the one per cent level.[11] Among the many exceptions to a relationship between growth and coach percentages are the high rates on Dayton and on Cleveland routes as well as on the Los Angeles-Denver route. Quite a few routes show low growth rates despite high coach fares, such as those to Kansas City and some of those to the Arizona resorts.

Thus, it appears that there are two factors significantly related to differential growth in air travel among the 99 city pairs—resort travel and length of haul. Neither of these are directly related to competition. It is probable, therefore, that the great air traffic growth from 1949 to 1954 is related to a basic change in American travel habits so sweeping as to render difficult the relation of growth differentials to explicit CAB policy regarding competition. For purposes of analysis, it is fortunate that a third possible factor, coach service, is less clearly significant since it should bear some relation to competition. Elimination of coach effects would therefore carry with it the risk of eliminating some competitive effects.

The first step in an attempt to isolate possible effects of competition is to eliminate the 24 Florida city pairs and separate the remaining city pairs onto three groups of maps, showing one-, two-, and three-carrier pairs (Figure 2). The growth categories are the same as in Figure 1. The resulting visual impression is that there is no strikingly consistent tendency for growth rates to increase from left to right. What tendency there is seems to be associated with the concentration of high-increase California traffic on the three-carrier map. A progression in growth rates does show up, however. The one-carrier pairs had an average growth rate of 129 per cent, the two-carrier pairs had an average of 133 per cent, and the three-carrier pairs had a high average of 207 per cent. This last, however, included an extremely high figure for Los Angeles-Las Vegas traffic which possibly should have been excluded in view of its similarity to the Florida resort traffic. The average without Los Angeles-Las Vegas for the three carrier pairs was 175 per cent. The difference between the categories was tested by use of analysis of variance. This consists of a comparison of the variation *between* groups with the variation *within* groups. Is the difference in average growth rates between the one-, two- and three-carrier pairs, for instance, a difference which might occur merely by chance in view of the amount of variation in growth rates which still exists within each of these categories? The between-group and within-group estimates of variation are then expressed as a ratio and referred to probability tables. The

[11] That is, a coefficient of such magnitude could be obtained purely by chance one time in one hundred even though no relationship actually existed.

greater the between-group variance estimate relative to the within-group estimate the higher the ratio and the less likely it is that the difference in means between the groups is due merely to chance. In this case the resulting "F" ratio (3.74) tested as significant at the five

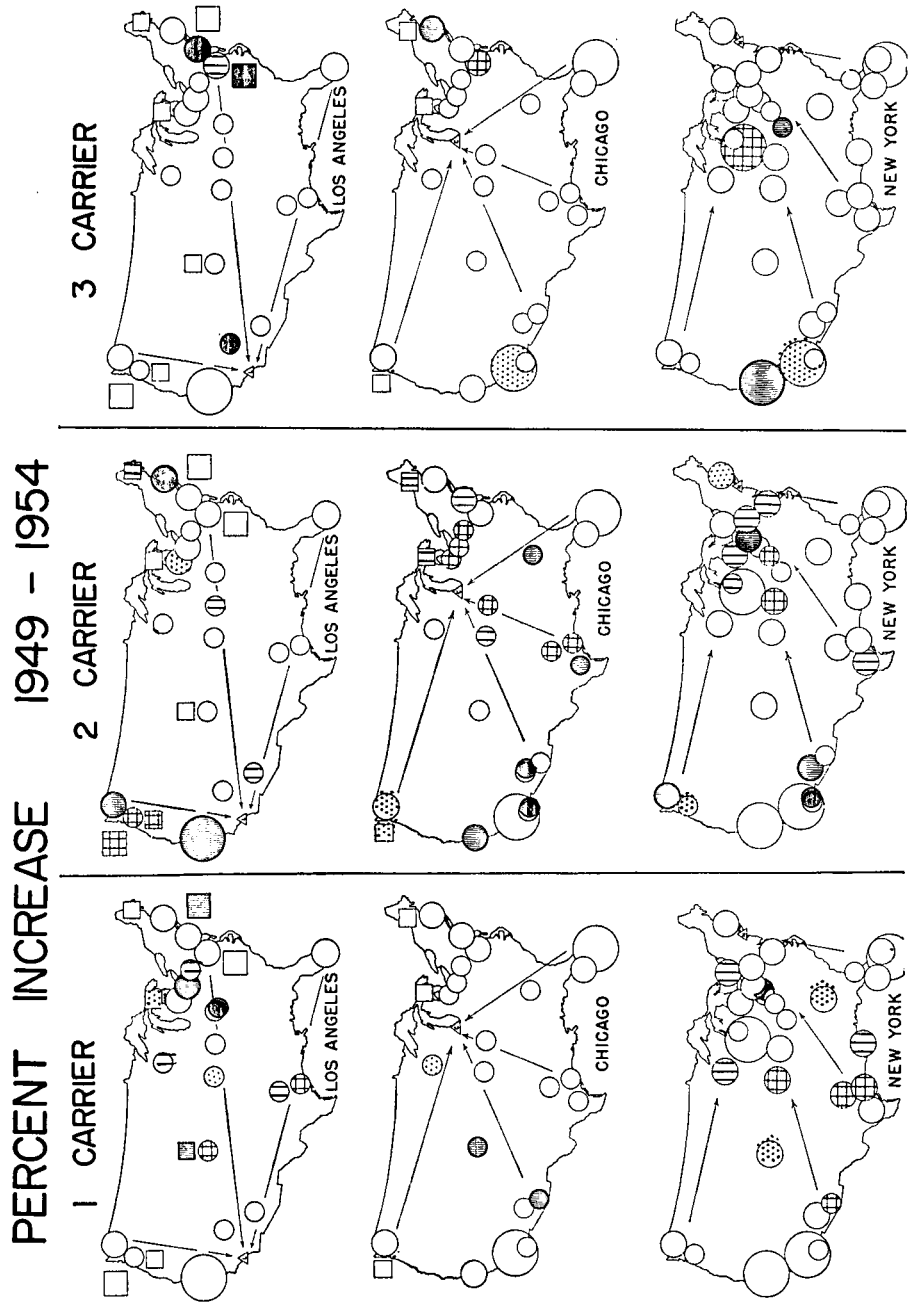

Figure 2 — Percentage Increase for 1949-1954 Traffic Grouped According to Number of Competitors

per cent level (3.13) but not at the one per cent level (4.92).[12] When the Los Angeles-Las Vegas route was excluded, however, the F ratio was appreciably below both the five and the one per cent levels.[13] Similar results were obtained from tests utilizing a five per cent share of the market as the criterion for effective competition so as to reduce possible distortions associated with the arbitrary ten per cent definition. Thus, if one were to exclude Los-Angeles-Las Vegas on the ground that it is clearly a resort pair, the separation of non-resort pairs into three groups according to the number of effective competitors did not separate high and low growth rates in any statistically significant fashion, although the progression in average growth rates should certainly be noted.

Since coach services also may have some relation to traffic growth, it is of some interest to investigate the relationship between coach services and competition. One would expect the percentage of coach service to increase with the number of competitors. However, even the averages fail to bear this out. The one-carrier pairs had an average rate of 29 per cent coach passengers, a figure actually higher than the 27 per cent recorded for the two-carrier pairs. Three-carrier pairs had an average of 37 per cent. The use of analysis of variance on these data indicated that differences were not significant either between all three groups or between the two- and three-carrier groups. This may indicate, at least tentatively, that decisions to introduce effective coach fares are more affected by the nature of the traffic, length of haul, particular airlines concerned, etc., than by the number of competitors.[14]

The next step in the evaluation of growth rates is to attempt to modify the complicating factor of length of haul. The variation within the groups may be due to differences in length of haul which conceivably might obscure an actually close relationship between growth and number of competitors. The scatter diagram in Figure 3 represents an attempt to modify this factor. The regression line represents the weak average relationship between traffic growth and length of haul. Dots located above the line represent routes on which growth has been

[12] As applied to random sampling, this would mean that a figure as high as 3.13 could be obtained purely by chance in five out of one hundred trials even though there were no significant differences between the groups; a figure as high as 4.92 would be obtained only once in one hundred trials. One might regard this example as a case wherein the hypothesis under examination is that the one-, two-, and three-carrier growth rates could represent samples from the same statistical universe. Low ratios mean that this hypothesis might be accepted and that the groupings according to number of competitors does not result in any greater difference in means than would be expected from normal sampling error. Certain difficulties involved in applying this measure to non-random samples indicate that the terms "significant" and "insignificant" are relative and should be accepted with considerable caution. Here too, however, the device is considered as a useful aid to precise comparison in that it provides a numerical check on the evaluation of between-group variation by weighing it against remaining within-group variation.

[13] When the Los Angeles-Las Vegas route is included, the variance of the three groups is non-homogeneous so the size of the ratio is not traceable entirely to differences in the means. When this route is excluded, however, the requirement of homogeneity of variance is met.

[14] TWA's emphasis on coach services, for instance, shows up in the high coach percentages on many important TWA pairs.

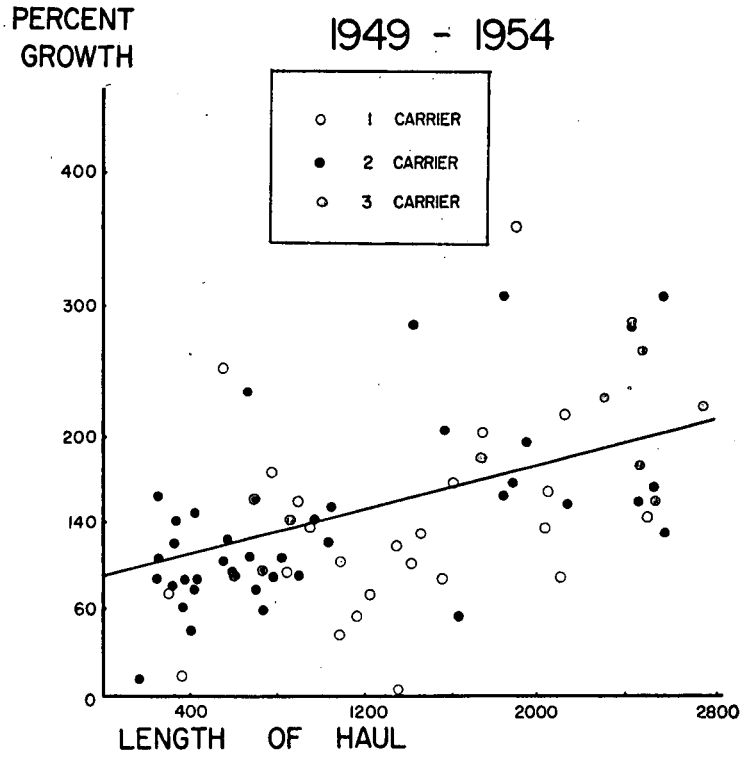

Figure 3 — Regression of Growth on Length of Haul, 1949-1954

greater than expected from the average relationship between length of haul and growth; dots below the line indicate growth which has been less than expected from this relationship. The residual variations as represented by the position of the dots have been categorized into three groups according to competitors. The red dots represent three-carrier routes; the blank dots represent one-carrier routes. Visual inspection of the scatter suggests a slight improvement in the relation of growth to competition, although there is still by no means a consistent grouping of three-carrier dots above the line or one-carrier dots below the line.

Figure 4 represents the spatial distribution of these residual variations. The legend categories are similar to those on the growth map. The shaded category represents those dots (city pairs) which are clustered close to the regression line; the red patterns represent dots well above the line (city pairs with a greater growth rate than would be expected from that length of haul); the light, black-and-white patterns represent dots well below the line.[15] Note how the distance effect has

[15] Each category is approximately one-half a standard error of estimate in width. The categories are as follows:

red:	+101 or more
red lines:	+ 61 to +100
red dots:	+ 21 to + 60
shading:	+ 20 to — 20
cross-hatch:	— 21 to — 60
lines:	— 61 to —100
dots:	—101 or less

been modified, particularly on the New York and Chicago insets. Closer examination of some of the highs on this map indicates the multiple product nature of air transportation as it is reflected in the many specific institutional factors associated with growth. The Las Vegas-Los Angeles

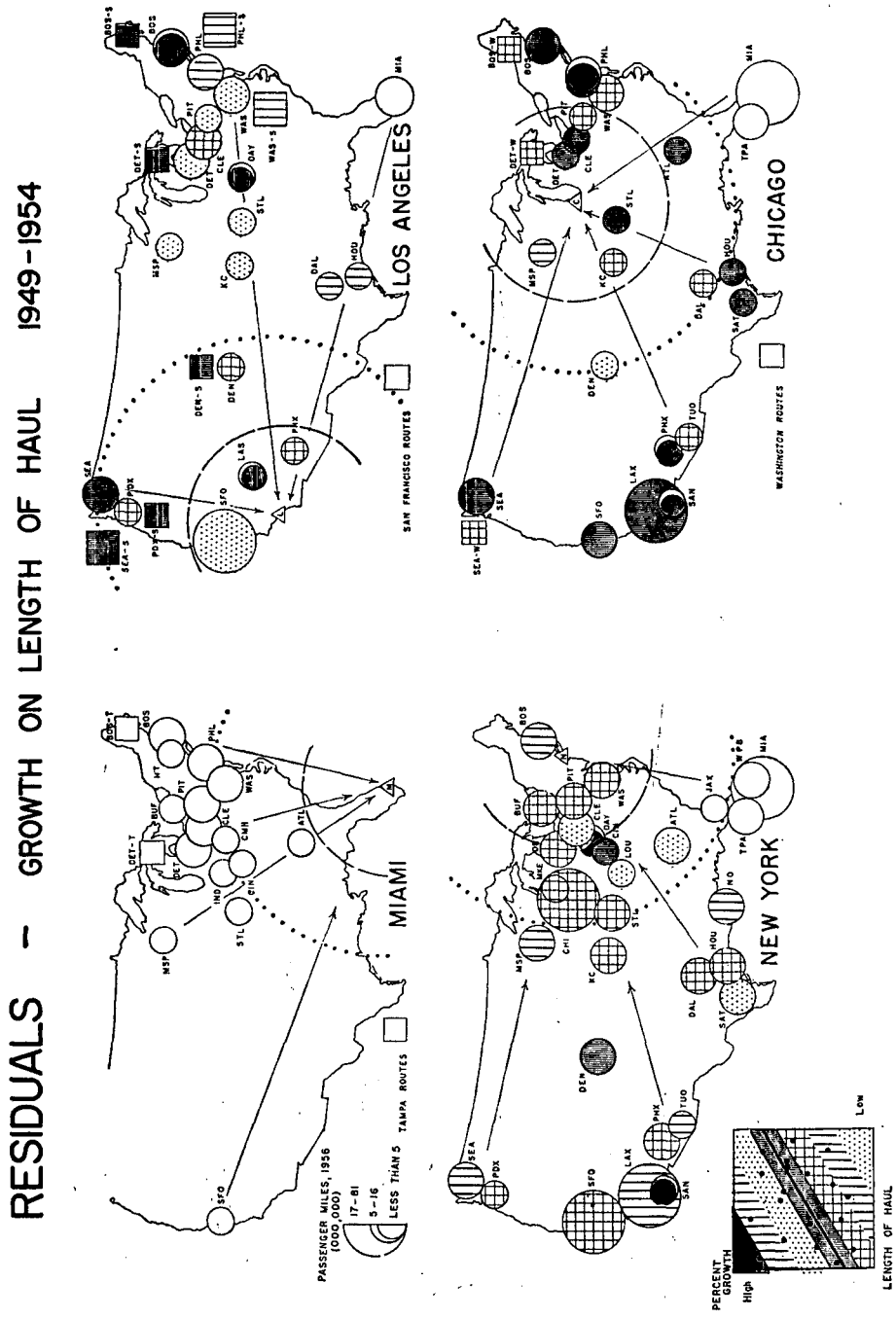

Figure 4 — Residual Deviations from a Regression of Growth on Length of Haul, 1949-1954

route is obviously set apart from the others and ranks with the Florida resort routes in the degree of increase. Dayton traffic on both the New York and the Los Angeles maps is of such magnitude as to indicate the influence of Air Force activities at Wright Field. San Diego traffic on the New York and Chicago maps is high because of the large number

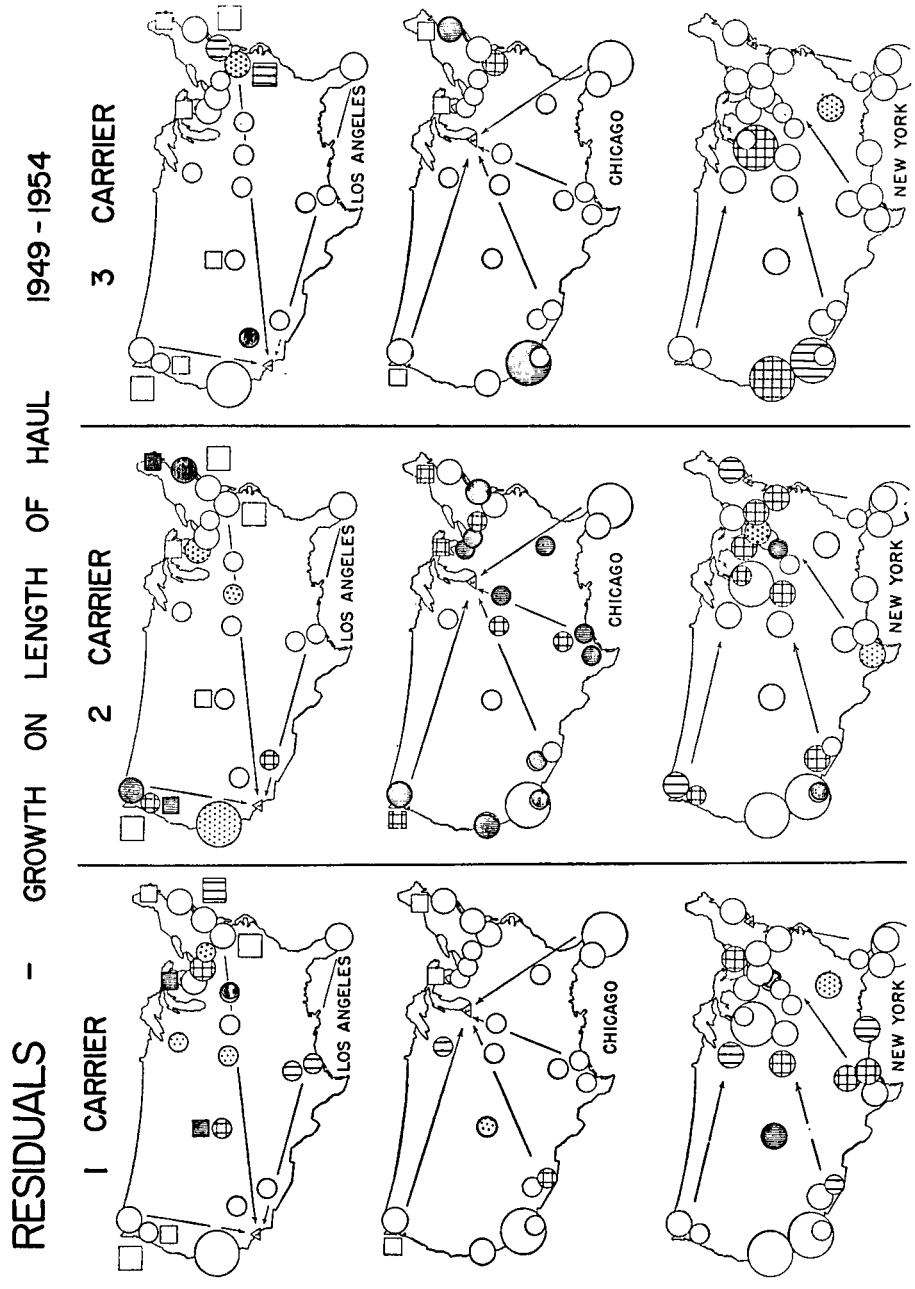

Figure 5 — Residual Deviations from a Regression of Growth on Length of Haul Grouped According to Number of Competitors, 1949-1954

of servicemen utilizing the commercial airlines. Philadelphia traffic growth may be related to improvements in local facilities and services. Specific institutional factors such as airline equipment problems or severe rail competition may also be related to the lows on the map as possibly in the case of Minneapolis-St. Paul traffic to Chicago as well as to New York. It is also interesting to note that California traffic in general seems to show greater growth than would be expected from the average relationship between growth and length of haul. Here too, there is some evidence of the pattern noted on the Florida map. Los Angles traffic to New York and Chicago seem to be increasing less rapidly than that to other Manufacturing Belt cities.

Figure 5 presents these residual variations separated onto three maps according to number of competitors. If the hypothesis of a relationship between growth and number of competitors is correct, there should be a noticeable progression from low to high residuals as one moves fom one- to three-carrier pairs, since the Florida resort traffic has been eliminated and the length of haul effect has been modified. As was anticipated from the scatter diagram there is no clear-cut separation of high and low growth rates. Although lows dominate the one-carrier insets, there is a scattering of highs including such conspicuous monopoly pairs as Los Angeles-Pittsburgh, Chicago-Denver, and New York-Atlanta. On the three-carrier insets, New York-Los Angeles and Chicago-Los Angeles drop out of the high category (see Figure 2) so that the lows provide more of a balance to such highs as those on the Los Angeles map representing traffic between the West Coast, on the one hand, and Philadelphia or Washington on the other. Certain minor qualifications should be noted, however. On the one-carrier, Los Angeles inset, the growth of Los Angeles-Minneapolis traffic may be associated with the fact that this city pair had been certificated for single-carrier service by 1954 as opposed to connecting services in 1949. On the three-carrier, Los Angeles inset, the phenomenal growth of the Los Angeles-Las Vegas resort traffic may be related to some lesser degree with competition. In 1949, Western monopolized this traffic; in 1954, Western, TWA, and United were effective competitors.

An attempt was made to apply analysis of co-variance to these regression residuals but with inconclusive results because of the nature of the data.[16] Adjustment of the average growth rates to compensate for length of haul effects resulted in a somewhat more regular progression; 124 per cent for the one-carrier pairs; 146 for the two-carrier pairs; and 152 for the three-carrier pairs excluding Los Angeles-Las Vegas.

[16] Analysis of covariance is essentially the application of analysis of variance to regression residuals. That is, do the means of the one-, two-, and three-carrier residuals vary significantly between the groups in the light of the amount of variation among the residuals within each group? It is more complicated because differences between groups may be associated with the slope of the regression line as well as with the group means (elevations of the regression lines for each group) and with group variance. Even with the Los Angeles-Las Vegas route excluded, the differences in variance between the three groups were too great to permit an evaluation of the difference in means.

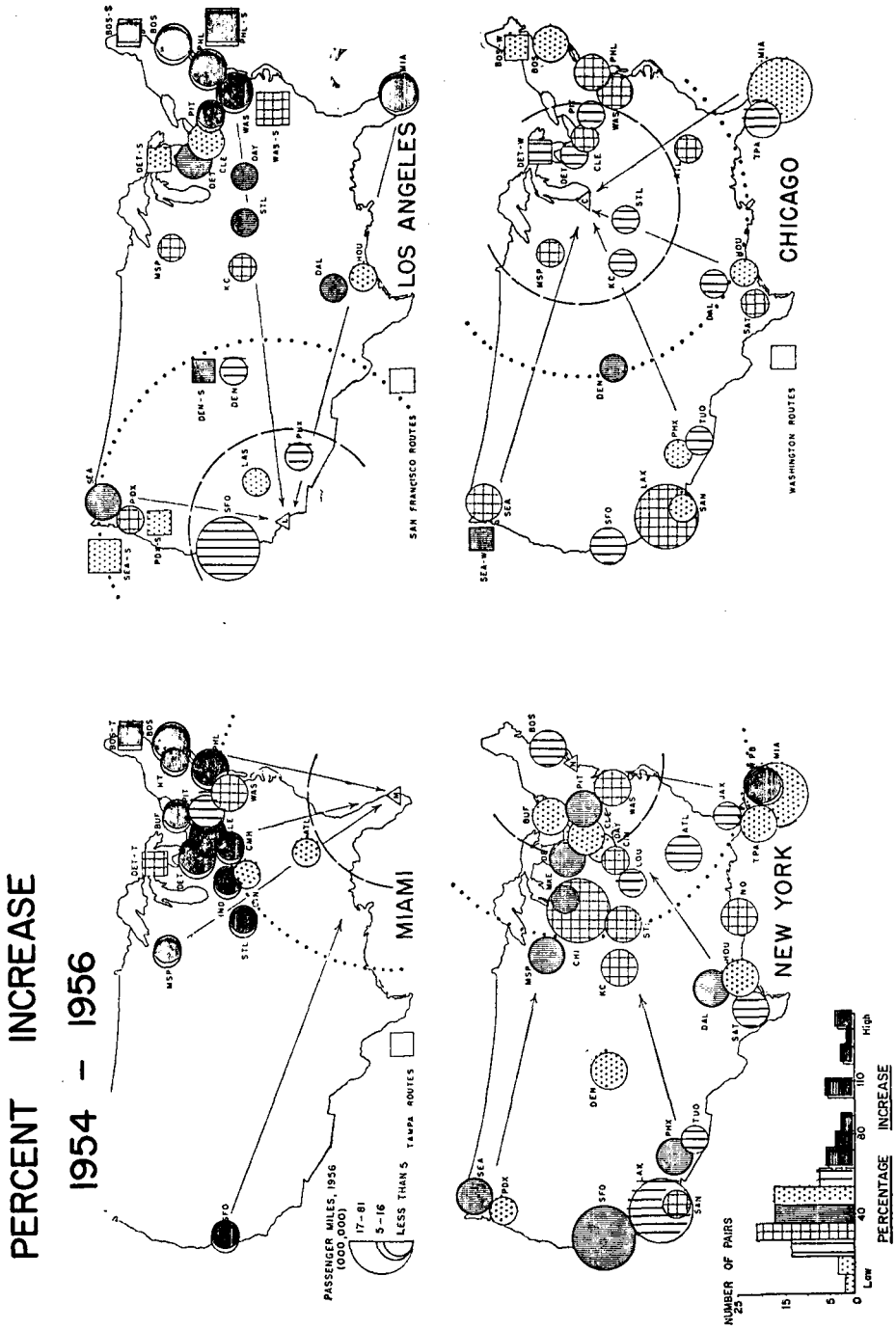

Figure 6 — Percentage Increase in Air Traffic from March and September, 1954 to March and September, 1956

Thus, the net result of the examination of 1949-1954 growth is to indicate the difficulty of isolating possible growth effects of number of carriers on individual routes. No statistically conclusive evidence of a relationship between growth and number of carriers has been discovered although there are interesting progressions in average growth rates.

Traffic Growth from 1954 to 1956

Figure 6 carries the growth rate analysis into the recent period of competitive change, 1954-1956. The growth rate for U. S. total passenger miles was considerably less for this shorter period (39 per cent as compared to 136 per cent). The histogram-legend indicates also that the frequency distribution of growth rates was somewhat more concentrated. The coefficient of variability for the non-resort pairs went from 58 per cent down to 47 per cent. More than half of the New York and Chicago routes had growth rates between 20 and 40 per cent. The legend is again arranged with the shaded pattern centered on the mean (excluding the Florida pairs) and each category is again ½ a standard deviation in width so that the two maps may be effectively compared. The factors noted on the 1949-54 map continued to affect growth during the two-year period of competitive change. Resort traffic continued to grow far more rapidly than other traffic. The Florida resorts have an average rate of increase of 80 per cent on Figure 6 as compared to the total growth rate of 39 per cent. The previously observed contrast between moderately high Florida growth rates on New York and Chicago routes and extremely high rates on newer routes to other Manufacturing Belt Centers, is even more marked on Figure 6 where the Miami-New York and Miami-Chicago routes now have dropped out of the highest category. The different nature of Florida air traffic as compared to other winter resort travel is also more evident on Figure 6, in the contrast between the high rates of growth on the Miami map and the low rates of growth for the Arizona resorts (Phoenix and Tucson) on the New York and Chicago maps.

Statistically, the effects of length of haul seem to bear just about the same weak relationship to the short-term growth on Figure 6 as to the longer term growth on Figure 1. The correlation coefficient is .42 as compared to the previous .40. Map inspection leaves one with the impression that, although the over-all relationship is about the same, individual growth rates display a considerably more erratic progression with distance. This is particularly noticeable on the Chicago map where low growth rates are recorded at the Texas and Arizona cities, as well as at the Arizona resorts. There are also a number of high-increase short-haul city pairs. (On the New York map, note Buffalo, Cleveland, Dayton, and Louisville; Pittsburgh on the Chicago map; Phoenix and Denver on the Los Angeles map.) Table 2 presents the variation with broad distance zones.

Length of Haul (miles)	*Average Growth Rate* (per cent)
Below 500	35
500-1000	37
1000-1500	32
1500-2000	37
Over 2000	51

The drop-off in growth in the 1000 to 1500 mile zone is probably associated with weak growth of Chicago's Texas traffic, as well as New York's Kansas City and New Orleans traffic. It is interesting to note that the hauls of greater than 2000 miles now record a sharply increased growth rate as the West Coast traffic to such Eastern Seaboard centers as Boston, Philadelphia, and Washington grew quite rapidly, possibly with the initiation of non-stop services. It is probable, in fact, that these particular high-growth, long-haul city pairs pulled the correlation coefficient up to its previous level even though the relationship between growth and length of haul visually seems less consistent. The 33 California city pairs still had a somewhat greater average rate of increase than the total increase (49 as compared to 39 per cent) despite the apparent effects of the Western Airlines pilot strike on the Los Angeles and San Francisco traffic to Las Vegas and the Pacific Northwest.

Coach fares are still only weakly related to growth as is indicated in Table 2 in the appendix. The correlation coefficient of .24 is obtained from simple linear regression. Just as previously, this figure is significant at the 5 per cent but not at the 1 per cent level. Among the low coach percentage pairs with high growth rates are New York routes to Buffalo as well as to Dayton; among the high coach percentages with low growth rates are both New York and Chicago routes to the Arizona cities, New York-Atlanta, and Chicago-San Francisco.

Figure 7 shows the growth rates again divided onto three maps according to the number of competitors. Map inspection indicates no consistent difference in growth rates between one-, two-, and three-carrier pairs. On the three-carrier insets there are as many growth rates in below-average categories as there are in above-average categories; on the one-carrier insets there are almost as many in above-average categories as in below-average. This visual impression is supported by the average growth rates. One-carrier pairs average 40 per cent, actually slightly higher than two-carrier pairs which averaged 38 per cent, but less than the 47 per cent recorded for the three-carrier pairs. Analysis of variance tests indicated that the differences between the three groups were statistically insignificant—as were differences between both the one- and three-carrier groups and the two- and three-carrier groups. The relationship between coach percentages and number of competitors also proved statistically insignificant with averages of 33, 33 and 41 for the one-, two-, and three-carrier pairs respectively. Again, the 5 per cent definition of effective competition was applied and again both growth rate and coach variations according to competitive groupings tested as insignificant.

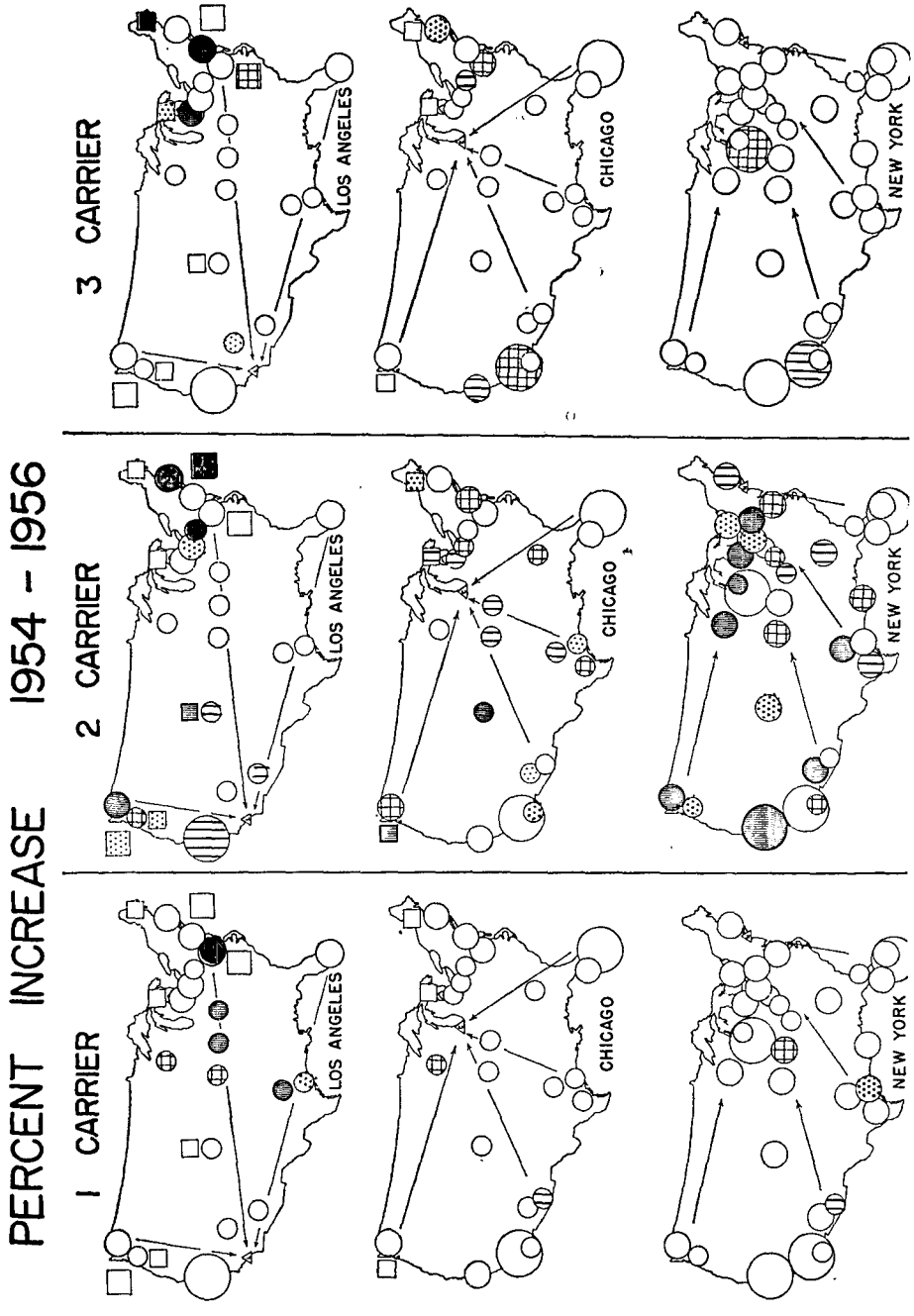

Figure 7 — Percentage Increases for 1954-1956 Grouped According to Number of Competitors

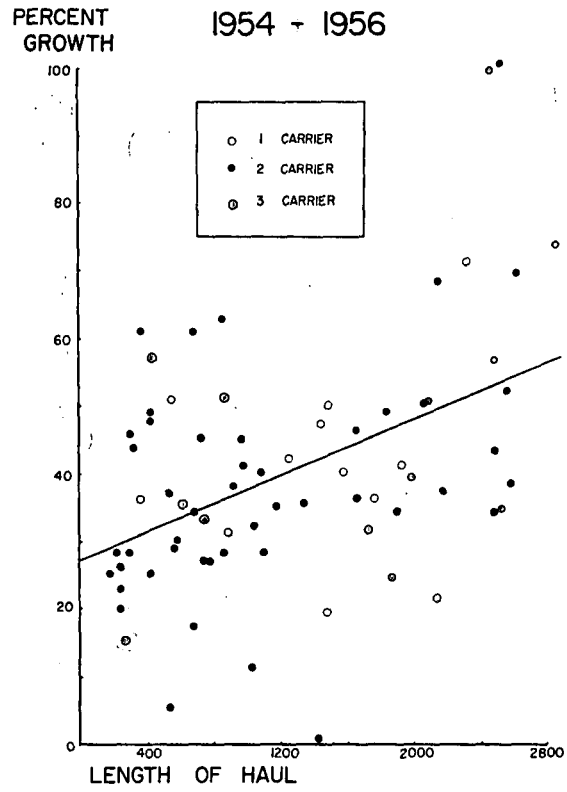

Figure 8 — Regression of Growth on Length of Haul, 1954-1956

Figure 8 is the scatter diagram showing the relationship between growth and length of haul for the 1954-1956 period, and the residual deviations from that relationship. There seems to be less tendency for the one-carrier pairs to cluster below the line and the three-carrier pairs to cluster above the line than was true in the previous period. Figure 9, representing the spatial distribution of the residual variations separated onto maps of one-, two- and three-carrier pairs also indicates the weakness of this tendency.[17] Although there are very few highs on the one-carrier insets, there are correspondingly few highs on the three-carrier insets. Most of the growth rates in excess of what might be expected from the average relationship between growth and length of haul are to be found on the two-carrier insets. Interpretation of growth is again complicated by the fact that a large number of highs seem to be concentrated on the Los Angeles map independently of competitive characteristics. Also, the increased number of two-carrier pairs left the one- and three-carrier groups more susceptible to distortion from the effects of purely institutional factors. Analysis of covariance tests indi-

[17] The regression residuals for 1954-1956 are also categorized into groups of one-half a standard error of estimate so that Figure 9 may be compared with Figure 5, the 1949-1954 residuals map.

cated that the differences between the residual variations of the three groups were not statistically significant. Adjustment of the means to compensate for distance effects, however, did result in a very weak tendency for growth rates to increase with number of competitors: 38.7

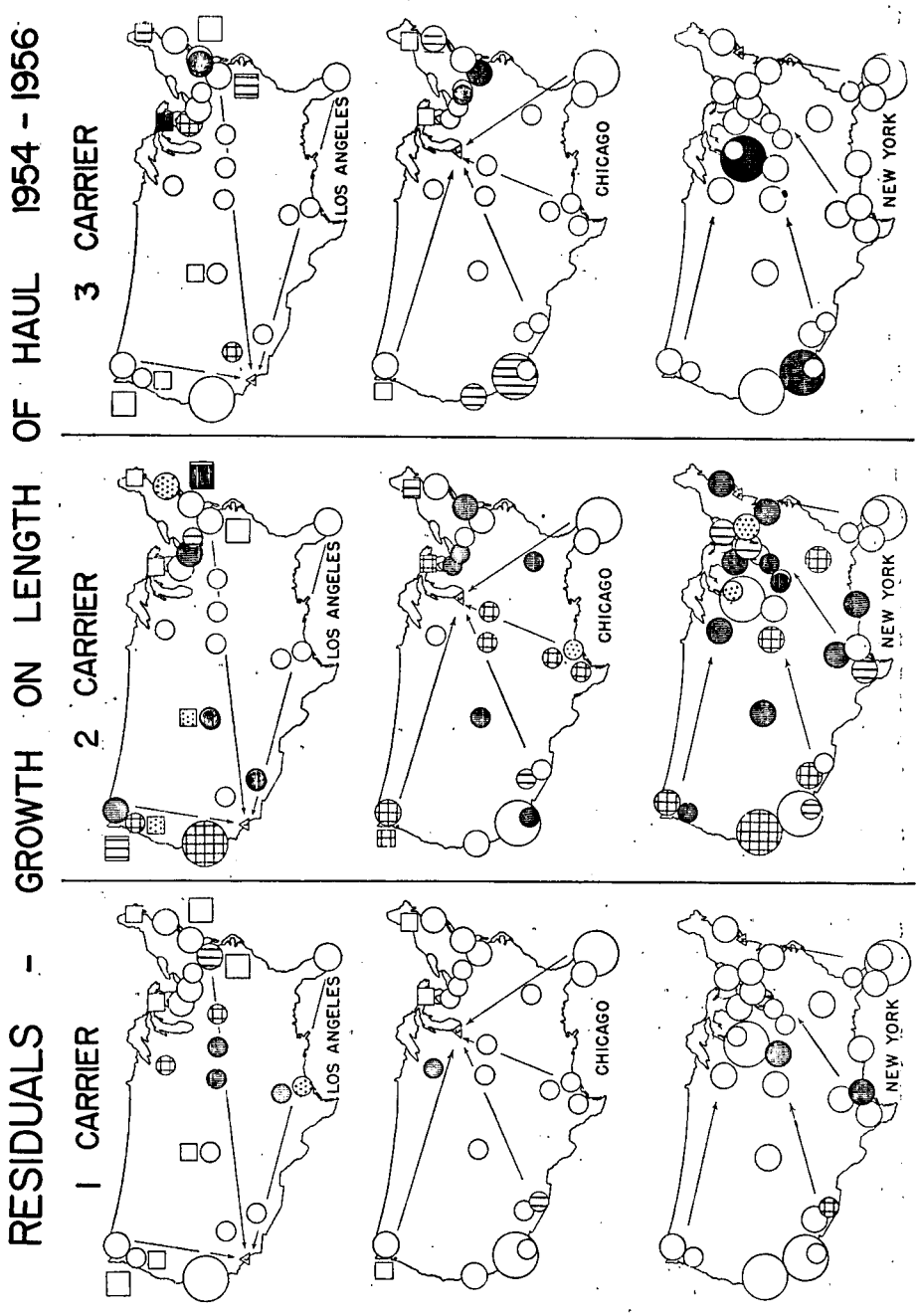

Figure 9 — Residual Deviations from a Regression of Growth on Length of Haul Grouped According to Number of Competitors, 1954-1956

for one-carrier pairs; 39.4 for two-carrier pairs; 44 for three-carrier pairs. The net result of the examination of 1954-1956 growth rates, however, is a failure to uncover indications of a relationship between rate of growth and number of competitors. If anything, this lack of relationship is indicated more strongly by the 1954-1956 data, since there is less contradictory evidence than was true in the 1949-1954 case.

Traffic Growth on the Competitive-Increase Pairs

The next step in evaluating the relationship between growth and competition among the leading city pairs is to consider separately the growth rates of those city pairs which have experienced an increase in competition. Twenty-one of the 75 non-resort pairs were designated as competitive-increase pairs. Seventeen of these were city pairs on which an additional competitor had more than doubled its share of the market to attain a total of ten per cent. The other four include those on which the additional competitor had more than doubled its share to reach 5 per cent. It should also be noted that competitive increases at nearly all of these pairs were the result of the 1955-1956 CAB decisions.

Growth rates of the competitive-increase pairs for 1949-1954 and 1954-1956 are presented on Figure 10. The categories used are the same as in the two growth maps. Since each category represents one-half a standard deviation the two insets in Figure 10 are comparable in terms of dispersion from the mean. Preliminary inspection of these maps suggests that at this point in the investigation signs begin pointing to a possible relationship between growth and competition. Some of the city pairs previously cited as having unusually high growth rates for their distance zone or coach percentage[18] are seen to be city pairs which have experienced competitive increase. In terms of specific growth rates on the maps it might be noted that the competitive-increase pairs which grew most rapidly between 1954 and 1956 included a number involved in the pattern of reciprocal awards whereby TWA and United Air Lines entered a number of each other's markets[19] (New York to Cleveland and to Denver; Chicago to Pittsburgh; Los Angeles to Pittsburgh and to Denver) ; and the New York-Buffalo market where Capital's Vicker's Viscount has apparently had an unusual impact.[20]

Analysis of variance was then applied to the difference in growth rates between the 21 competitive-increase pairs and a control group consisting of the 54 non-resort pairs which did not experience an increase in competition. In both cases, the differences tested as insignificant. In the 1949-54 case, the average for the competitive-increase group was 124 per cent, appreciably lower than the 150 per cent recorded for the control group. In the 1954-56 case, however, the average

[18] Notably Buffalo and Cleveland on the New York map, Pittsburgh on the Chicago map, Denver on the Los Angeles map.

[19] See Taaffe, *op. cit.*, pages 134 and 138. These compensatory awards are indicated correctly on the maps although the omission of an entire line from the text on p. 142 results in a misleading statement with reference to the individual routes concerned.

[20] Taaffe, *op. cit.*, pages 137 and 141.

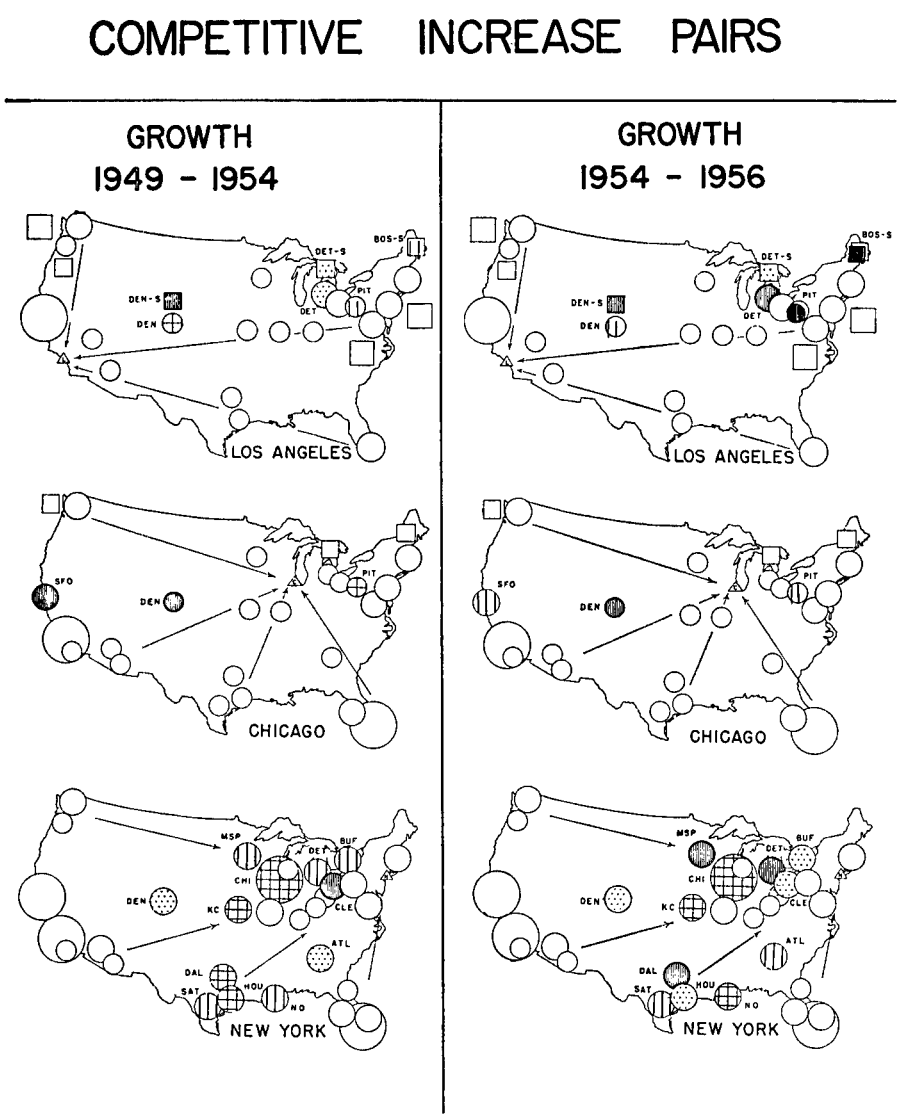

Figure 10 — Percentage Increases for Competitive-Increase Pairs, 1949-1954 and 1954-1956

for the competitive-increase group was 43.90 per cent, as opposed to 38.57 per cent for the control group. Despite the fact that this difference in means could not be regarded as statistically significant in the light of the amount of variation still present within each of these groups, it is a matter of considerable interest to note how the competitive-increase group had improved its position relative to the control group. This shows up on the map in the form of the many competitive-increase city pairs which moved into higher growth-rate categories in 1954-1956. Particularly striking examples are New York-Buffalo, Chicago-Pittsburgh and Los Angeles-Denver, each of which moved up three

growth-rate categories. Eleven of the competitive-increase pairs moved to a higher category while only three moved to a lower category. Differences in coach fare percentages also tested as insignificant in both study periods. Here too the average for the competitive-increase group went from slightly below to slightly above that of the control group. The differences were not as marked as in the case of growth rates, however.

Examination of residuals for the 21 competitive-increase pairs led to similar conclusions. Changes on work maps were so slight in magnitude that no presentation map was deemed necessary. This indicates that differences in growth associated with length of haul do not affect either: (a) the fact that the average growth rates of the competitive-increase pairs do not differ in a statistically significant fashion from the average growth rates of the control group; or (b) the fact that the average for the competitive-increase pairs has gone from appreciably below to somewhat above that of the control group.

Summary

On balance, it seems reasonable to say that this examination of the traffic characteristics of the 99 leading city pairs has not conclusively demonstrated that there is a relationship between air traffic growth and airline competition, or between the offering of effective coach services and airline competition. To this extent the findings are similar to those of the previous studies. The observation of individual city pairs on the map and the contradictory implications of some of the measures, however, leads to considerably more equivocal findings regarding competition and growth than was true in the other cases. There has been enough doubt cast on the broad statement above to warrant the inclusion of several important qualifications. First, although the findings were largely negative for comparisons involving one-, two-, and three-carrier pairs they had important positive aspects for competitive-increase pairs. This leads one to postulate a possible difference between the initial impact of added competition and longer-term effects. It is possible that a significant amount of new traffic is generated by the entry of a new carrier but that this effect levels off after a period of time so that there is no measurable relationship between rate of growth and number of competitors. Secondly, there is enough conflicting evidence in the longer term case (particularly 1949-1954) to provide fuel for speculation as to the effects of competition being temporarily submerged during the periods considered, when the nation's travel habits were apparently undergoing a large-scale change. A circumspect conclusion in this regard might be that the weight of evidence to date points to the difficulty of isolating any possible relationship between rate of growth and number of competitors. A third qualification to the broad general conclusion is that growth in air travel is spotty and erratic when observed over individual routes. This becomes something more than a truism when one considers that

the CAB must make use of individual routes in implementing its efforts to promote competition. The contrast in the traffic reaction of different city pairs to the addition of a carrier is associated with the many institutional factors evident from the maps. In addition to length of haul and Florida resort travel, a particular growth rate may be greatly affected by an individual airline's equipment policy, severe rail competition, unusual travel to such cities as Los Angeles and San Francisco, service-connected travel, etc. Rather than assume that all these disturbances will neatly cancel out, it seems useful to note the more conspicuous of these factors in order to attain a suitable degree of disenchantment with the resulting generalizations—and to be particularly cautious about taking a few selected city pairs as being typical exemplifications of competitive or other effects. Then too, certain of these apparently institutional factors may prove to be of such a nature as to be susceptible of ultimate systematization thereby refining, strengthening and quite possibly altering, the generalizations.

Thus, an empirical examination of the 100 leading city pairs has led to certain broad conclusions regarding the relationship between airline competition and air traffic. From the first part of the study it could be concluded that the entry of a new carrier often but not always accompanied a sizable percentage diversion of traffic. It was also noted that recent awards have favored the expansion of regional carriers into Big Four markets. This reduced the disproportionate Big Four share of the premium markets and created, at least initially, a pattern dominated by two-carrier, effective competition if one were to use the 10 per cent criterion. The latter portion of the study indicated that the effects of competition in stimulating growth and effective low-fare service over specific routes must still be considered as unproven, although some statistically inconclusive evidence did suggest that at least the initial impact of added competition does produce above-average growth rates.

The fact that there is considerable evidence of competitive diversion coupled with the lack of evidence that competition stimulates growth over individual routes would seem to indicate that the original carriers have experienced traffic losses with the entry of a new carrier. This, of course, is not necessarily the case. It is quite possible that the original carrier may have had its percentage share of the market reduced on a route with below-average traffic growth and still experienced an absolute increase in passengers carried due to the great increase in over-all air traffic. It might even be argued that such over-all traffic growth might have been stimulated by the effects of a generally more competitive airline industry in the form of better services, more national advertising, accelerated equipment innovation, etc. On the other hand, it should also be noted that even if an original carrier had gained an absolute increase over a particular route in the face of increased competition, this might have been accomplished only with a disproportionately great increase in scheduled seats. Thus, a close examination of

changes in load factors on competitive-increase routes would seem to be a requisite to an evaluation of the harmful economic effects of added competition on original carriers. Even with load factor information, however, many complicating factors would remain, such as a possible increase in coach percentages, greater promotional expenditure, or system-wide economic repercussions of diversion of equipment from other routes. Possible avenues of further investigation might include the use of more complete data (including schedule and cost estimate data) [21] which would necessitate more refined analytical tools, or the use of case studies so as to facilitate detection of the specific means whereby competitive diversion or unusually rapid growth are brought about on selected individual routes.[22] Experimentation with other definitions of competition, and closer examination of the growth characteristics of competitive-increase pairs over longer periods of time should also aid continued efforts of investigators to arrive at objective evaluations of the effects of airline competition.

APPENDIX

The following tables represent the data from which the growth maps were made. For each city pair the first-named city represents the map on which the pair has been plotted.

TABLE 1

City Pair	*Percentage Increase 1949-1954*	*Percentage Coach Passengers 1954*	*Length of Haul*	*Effective Competitors 1954*
Map Category: Red (A growth rate of 241 per cent or more)				
1. Miami-Hartford	732	—	1,192	1
2. Miami-Philadelphia	544	80	1,017	2
3. Los Angeles-Las Vegas	521	37	248	3
4. Miami-Buffalo	488	—	1,392	0
5. Miami-Pittsburgh	463	39	1,108	1
6. Miami-Detroit	392	34	1,196	1
7. Tampa-Detroit	391	49	1,044	1
8. Los Angeles-Dayton	366	—	1,926	1
9. Miami-Cleveland	350	48	1,091	1
10. Miami-St. Louis	314	49	1,073	1
11. Chicago-San Diego	310	56	1,860	2
12. Los Angeles-Boston	307	54	2,610	2
13. Miami-Minn.-St. Paul	293	14	1,536	0
14. Chicago-Phoenix	288	25	1,446	2
15. New York-San Diego	283	39	2,467	2
16. Chicago-Miami	280	68	1,186	2
17. Los Angeles-Philadelphia	279	44	2,451	3
18. Miami-Cleveland	273	54	952	1
19. Miami-San Francisco	273	20	3,042	0
20. San Francisco-Washington	269	37	2,515	3
21. Miami-Columbus	261	—	1,067	1
22. Miami-Indianapolis	255	—	1,030	1
23. New York-Dayton	246	—	549	1
24. New York-Miami	243	57	1,100	2

[21] For example, the useful data being developed by Samuel B. Richmond in "Creating Competition Among Airlines," JOURNAL OF AIR LAW AND COMMERCE, XXIV, (Autumn, 1957) pages 435-464, should provide an excellent basis for critical evaluation of some of the tentative generalizations put forth in this study.

[22] Some work of this sort being carried on at the Transportation Center by George Post and Arthur Hurter on selected routes is producing further insights into the institutional complexity of the demand for air travel.

TABLE 1 — (Continued)

City Pair	Percentage Increase 1949-1954	Percentage Coach Passengers 1954	Length of Haul	Effective Competitors 1954
Map Category: Red Lines (201 to 240.5 per cent)				
25. Chicago-Philadelphia	230	26	671	2
26. Chicago-Tampa	229	43	1,001	1
27. Los Angeles-Washington	225	34	2,331	3
28. San Francisco-Boston	223	46	2,881	2
29. Tampa-Boston	220	38	1,356	1
30. Los Angeles-Minn.-St. Paul	219	49	1,773	1
31. Los Angeles-Pittsburgh	218	56	2,155	1
32. Los Angeles-St. Louis	203	66	1,596	2
33. Los Angeles-Miami	202	6	2,590	0
Map Category: Red Dots (161 to 200.5 per cent)				
34. Los Angeles-Detroit	198	26	1,970	2
35. Chicago-Los Angeles	182	59	1,751	3
36. New York-Atlanta	181	43	762	1
37. New York-Los Angeles	178	47	2,475	3
38. New York-Tampa	174	56	1,172	2
39. New York-West Palm Beach	170	8	1,038	2
40. New York-Denver	166	24	1,632	1
41. Washington-Seattle	166	21	2,496	2
42. Chicago-Seattle	162	37	1,896	2
43. New York-Portland	161	28	2,552	2
Map Category: Gray Shading (121 to 160.5 per cent)				
44. New York-Jacksonville	160	61	839	2
45. San Francisco-Detroit	160	22	2,064	1
46. Chicago-San Francisco	157	50	1,856	2
47. New York-San Francisco	150	43	2,580	3
48. Chicago-Denver	150	27	909	1
49. New York-Louisville	149	16	688	3
50. New York-Phoenix	147	39	2,167	2
51. Los Angeles-Seattle	142	26	964	2
52. Chicago-San Antonio	142	53	1,045	2
53. Los Angeles-San Francisco	140	48	340	2
54. Chicago-Boston	138	31	859	3
55. San Francisco-Philadelphia	138	41	2,525	1
56. New York-Cleveland	136	13	417	2
57. Los Angeles-Cleveland	130	16	2,058	1
58. Miami-Washington	126	24	922	2
59. Chicago-Tucson	126	60	1,487	1
60. New York-Seattle	122	41	2,620	2
61. Chicago-Atlanta	122	26	592	2
62. Miami-Atlanta	122	42	598	2
63. San Francisco-Denver	121	28	956	1
Map Category: Black Cross-Hatch (81 to 120.5 per cent)				
64. Chicago-Cleveland	116	7	307	2
65. Chicago-Houston	115	12	1,036	2
66. San Francisco-Seattle	113	32	687	2
67. New York-Dallas	113	22	1,381	1
68. New York-Kansas City	104	37	1,104	1
69. San Francisco-Portland	104	24	549	2
70. Chicago-Detroit	104	8	219	2
71. Los Angeles-Portland	103	26	832	2
72. New York-Houston	101	29	1,430	1
73. New York-Cincinnati	97	—	585	2
74. New York-Chicago	96	34	724	3
75. New York-St. Louis	92	29	888	2
76. Chicago-Dallas	91	16	795	2
77. New York-Tucson	91	41	2,134	1
78. Los Angeles-Denver	90	15	849	1
79. Los Angeles-Houston	87	7	1,486	0
80. Chicago-Washington	87	25	600	4
81. Chicago-Pittsburgh	82	8	420	2
82. Chicago-St. Louis	81	3	251	2
Map Category: Black Lines (41 to 80.5 per cent)				
83. Washington-Detroit	78	24	415	2
84. New York-Buffalo	77	—	292	1

TABLE 1 — (Continued)

City Pair	Percentage Increase 1949-1954	Percentage Coach Passengers 1954	Length of Haul	Effective Competitors 1954
85. New York-Pittsburgh	75	22	320	2
86. New York-Detroit	71	19	511	2
87. Washington-Boston	71	15	349	2
88. Los Angeles-Dallas	69	42	1,245	1
89. New York-New Orleans	64	43	1,186	1
90. New York-Milwaukee	62	20	739	2
91. Los Angeles-Phoenix	60	23	368	2
92. Chicago-Kansas City	55	27	405	2
93. New York-Washington	49	10	215	2
94. New York-San Antonio	47	41	1,631	2
95. New York-Minn.-St. Paul	46	20	1,080	1
Map Category: Black Dots (less than 40.5 per cent)				
96. Miami-Boston	19	60	1,284	1
97. Chicago-Minn.-St. Paul	14	21	350	1
98. New York-Boston	11	11	184	2
99. Los Angeles-Kansas City	9	61	1,368	1

TABLE 2

City Pair	Percentage Increase 1954-1956	Percentage Coach Passengers 1956	Length of Haul	Effective Competitors 1956
Map Category: Red (A growth rate of 64 per cent or more)				
1. Miami-Detroit	149	37	1,196	1
2. Tampa-Boston	146	38	1,356	1
3. Miami-Hartford	138	—	1,192	1
4. Miami-Columbus	129	—	1,067	1
5. Miami-Boston	128	60	1,284	1
6. San Francisco-Philadelphia	119	55	2,525	2
7. Los Angeles-Miami	107	36	2,590	0
8. Los Angeles-Philadelphia	102	62	2,451	3
9. Miami-Philadelphia	100	90	1,017	2
10. Miami-Minn.-St. Paul	100	6	1,536	0
11. Miami-Indianapolis	86	46	1,030	1
12. Miami-Buffalo	83	38	1,392	0
13. New York-West Palm Beach	81	31	1,038	2
14. Miami-San Francisco	79	37	3,042	0
15. San Francisco-Boston	74	47	2,881	3
16. Miami-St. Louis	72	66	1,073	1
17. Los Angeles-Washington	71	35	2,331	1
18. Los Angeles-Boston	69	49	2,610	2
19. Los Angeles-Pittsburgh	67	54	2,155	2
20. Miami-Cleveland	67	51	1,091	1
Map Category: Red Lines (55 to 63.5 per cent)				
21. Los Angeles-Denver	63	42	849	2
22. Miami-Pittsburgh	61	55	1,108	1
23. Los Angeles-Phoenix	61	39	368	2
24. New York-Louisville	61	22	688	2
25. Chicago-Tampa	58	60	1,001	1
26. Chicago-Pittsburgh	58	20	420	3
27. New York-Los Angeles	57	51	2,475	3
Map Category: Red Dots (46 to 54.5 per cent)				
28. New York-Portland	52	40	2,552	2
29. Chicago-Boston	52	27	859	3
30. San Francisco-Detroit	51	40	2,064	3
31. New York-Dayton	51	9	549	1
32. New York-Tampa	50	63	1,172	2
33. Los Angeles-Cleveland	50	38	2,058	2
34. Los Angeles-Houston	50	33	1,486	0
35. Chicago-San Diego	49	68	1,860	2
36. Chicago-Miami	49	68	1,186	2
37. New York-Cleveland	49	22	417	2
38. Miami-Cincinnati	48	59	952	1

TABLE 2 — (Continued)

City Pair	Percentage Increase 1954-1956	Percentage Coach Passengers 1956	Length of Haul	Effective Competitors 1956
39. Miami-Atlanta	48	38	598	2
40. New York-Miami	47	72	1,100	2
41. New York-Houston	47	31	1,430	1
42. Washington-Boston	47	18	349	2
43. New York-Denver	46	40	1,632	2
44. New-York-Buffalo	46	5	292	2
Map Category: Gray Shading (37 to 45.5 per cent)				
45. San Francisco-Denver	45	46	956	2
46. New York-Milwaukee	45	26	739	2
47. New York-Dallas	45	22	1,381	2
48. New York-Pittsburgh	44	24	320	2
49. Washington-Seattle	43	33	2,496	2
50. Los Angeles-Dallas	42	28	1,245	1
51. New York-Seattle	41	46	2,620	2
52. Los Angeles-Seattle	41	26	964	2
53. Los Angeles-Dayton	41	10	1,926	1
54. Los Angeles-St. Louis	40	55	1,596	1
55. Los Angeles-Detroit	40	46	1,970	3
56. New York-Minn.-St. Paul	40	24	1,080	2
57. New York-San Francisco	38	48	2,580	2
58. Chicago-Denver	38	41	909	2
59. New York-Phoenix	37	55	2,167	2
60. New York-Detroit	37	25	511	2
Map Category: Black Cross-Hatch (28 to 36.5 per cent)				
61. Los Angeles-Kansas City	36	61	1,368	1
62. Los Angeles-Minn.-St. Paul	36	30	1,773	1
63. Chicago-Washington	36	27	600	3
64. Chicago-Minn.-St. Paul	36	10	350	1
65. San Francisco-Washington	35	37	2,515	3
66. New York-New Orleans	35	37	1,186	2
67. Miami-Washington	34	57	922	2
68. New York-San Diego	34	55	2,467	2
69. Chicago-Seattle	34	48	1,896	2
70. Chicago-Philadelphia	34	34	671	2
71. New York-Chicago	34	34	724	3
72. Chicago-Los Angeles	32	56	1,751	3
73. Chicago-San Antonio	32	56	1,045	2
74. New York-St. Louis	31	29	888	1
75. New York-Cincinnati	30	—	585	2
76. Chicago-Atlanta	29	38	592	2
77. Tampa-Detroit	29	50	1,044	1
78. New York-Kansas City	28	34	1,104	2
79. Los Angeles-Portland	28	25	832	2
80. New York-Washington	28	16	215	2
81. Chicago-Cleveland	28	5	307	2
Map Category: Black Lines (19 to 27.5 per cent)				
82. New York-Atlanta	27	43	762	2
83. Chicago-Dallas	27	14	795	2
84. New York-San Antonio	26	47	1,631	2
85. Chicago-Detroit	26	15	219	2
86. Chicago-San Francisco	25	50	1,856	3
87. New York-Boston	25	11	184	2
88. Chicago-Kansas City	25	31	405	2
89. New York-Jacksonville	24	55	839	2
90. New York-Tucson	24	43	2,134	1
91. Los Angeles-San Francisco	23	51	340	2
92. Washington-Detroit	23	14	415	2
93. Chicago-St. Louis	20	5	251	2
94. Chicago-Tucson	19	50	1,487	1
Map Category: Black Dots (less than 18.5 per cent)				
95. San Francisco-Seattle	17	32	687	2
96. Los Angeles-Las Vegas	16	35	248	3
97. Chicago-Houston	11	10	1,036	2
98. San Francisco-Portland	5	30	549	2
99. Chicago-Phoenix	—12	57	1,446	2